

Appendix 2

IDENTIFICATION OF SPECTRAL IRREGULARITIES

1.0 INTRODUCTION

Spectral irregularities which are not produced by aircraft noise sources may cause tone corrections to be generated when the procedures of Annex 16, Volume 1 paragraph 4.3 of Appendix 1 and 2, are used. These spectral irregularities may be caused by:

- a) the reflected sound energy from the ground plane beneath the microphone mounted at 1.2 m above it, interfering with the direct sound energy from the aircraft. The re-enforcing and destructive effects of this interference is strongest at lower frequencies, typically 100 Hz to 200 Hz and diminishes with increasing frequency. The local peaks in the 1/3 octave spectra of such signals are termed pseudotones. Above 800 Hz this interference effect is usually insufficient to generate a tone correction when the Annex 16, Volume 1 tone correction procedures is used;
- b) small perturbations in the propagation of aircraft noise when analysed with 1/3 octave bandwidth filters; or
- c) the data processing adjustments and corrections such as the background noise correction method and the adjustment for atmospheric attenuation. In the case of the latter, the atmospheric attenuation coefficients (α) given in ARP866A ascribe α values at 4 kHz to the centre frequency of the 1/3 octave band whereas at 5 kHz the value of α is ascribed to the lower pass frequency of the 1/3 octave. This difference is sufficient in some cases to generate a tone correction.

The inclusion of a tone correction factor in the computation of EPNL accounts for the subjective response to the presence of pronounced spectral irregularities. Tones generated by aircraft noise sources are those for which the application of tone correction factors are appropriate. Tone correction factors which result from spectral irregularities, i.e. false tones produced by any of the above causes may be disregarded. This Appendix describes methods which have been approved for detecting and removing the effects of such spectral irregularities. However, approval of the use of any of these methods remains with the certifying authority.

2.0 METHODS FOR IDENTIFYING FALSE TONES

2.1 Frequency tracking

Frequency tracking of flyover noise data is useful for the frequency tracking of spectral irregularities. The observed frequency of aeroplane noise sources decrease continuously during the flyover due to Doppler frequency shift, f_{DOPP} where:-

$$f_{DOPP} = \frac{f}{1 - M \cos I}$$

where f is the frequency of the noise at source

M is the Mach number of the aeroplane

I is the angle between the flight path in the direction of flight and a line connecting the source and observer at the time of emission.

Reflection related effects in the spectra, i.e. pseudotones, decrease in frequency prior to, and increase in frequency after, passing the closest point of aeroplane passing overhead, or the lateral point. Spectral irregularities caused by perturbations during the propagation of the noise from the aeroplane to the microphone tend to be random in nature in contrast to the Doppler effect. These differing characteristics can be used to separate source tones from false tones.

2.2 Narrow band analysis

Narrow band analysis with filter bandwidths narrower than those of 1/3 octaves is useful for identifying false tones. For example when the analysis is produced such that the spectral noise levels at an instance are presented in terms of image intensity on a line, the overall flyover analysis clearly indicates the Doppler shifted aeroplane tones and those due to reflection as described in paragraph 2.1.

2.3 Microphone mounting height

Comparison of 1/3 octave spectra of measurements taken using the 1.2 m high microphone and corresponding data obtained from a neighbouring microphone mounted flush on a hard reflecting surface, a configuration similar to that described in paragraph 4.4 of Appendix 6 of ICAO Annex 16, volume 1, or at a height substantially greater than 1.2 m, such as 10 m, may be used to identify false tones. Changes to the microphone height alters the interference spectra irregularities from the frequency range of data from the 1.2 m high microphone and when a comparison is made between the two data sets collected at the same time, noise source tones can be separated from any false tones which may be present.

2.4 Inspection of noise time histories

Spectral irregularities which arise following data correction or adjustment (as described in (b) above) will occur in the frequency range of between 1 kHz to 10 kHz and the resulting false tone corrections will normally vary in magnitude between 0.2 to 0.6 dB. Time histories of perceived noise levels, PNL, and tone corrected perceived noise levels, PNLT, which exhibit constant level differences are often indicative of the presence of false tone corrections. Supplementary narrow band analysis is useful to demonstrate that such tone corrections are not due to aeroplane generated noise.

3.0 TREATMENT OF FALSE TONES

When spectral irregularities give rise to false tones which are identified by, for example, the methods described in Section 2 of this Appendix, their value, when computed in Step 9 of the tone correction calculation (described in Section 4.3 of Appendix 2 of Annex 16, Volume 1) may be set to zero.